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Sustainable Expression: Combining the Past and the Present to Create a Viable Vernacular

William Thomas Brown
University of Tennessee, Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by William Thomas Brown entitled "Sustainable Expression: Combining the Past and the Present to Create a Viable Vernacular." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Architecture, with a major in Architecture.

Scott Wall, Major Professor

We have read this thesis and recommend its acceptance:

Barbara Klinkhammer, C. A. Debelius

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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SUSTAINABLE EXPRESSION: COMBINING THE PAST AND THE PRESENT TO CREATE A VIABLE VERNACULAR

A thesis Presented for the Master of Architecture Degree
The University of Tennessee, Knoxville

William Thomas Brown
August 2006

DEDICATION

I would like to dedicate this thesis project to my family who have supported me through all the struggles to obtain this degree.

"What will it take for us to once again become indigenous?" – William McDonough

Thesis Statement: A new regional vernacular architecture can occur through a reuse of past sustainable design techniques combined with modern technology. This architectural expression is driven by the natural elements of a climate region as well as the modern technology available today. The combination of naturally driven systems and technologically driven systems can create a building that addresses the environmental concerns of today while conveying a viable vernacular.

Abstract:

This topic will involve an analysis of architecture of the past to reveal how sustainable design techniques were dependent on the natural environment of a specific climate region. This analysis of ancient building strategies will examine similar climate areas to the Southeast United States and combined the information with modern 'green' technologies. The final result being a building whose expression reflects a new regional vernacular. Before the age of electric heating and cooling systems and thermal insulation, buildings were designed to take advantage of their natural surroundings. In fact, these structures depended on its natural surroundings and this dependence informed the architectural expression. Designers of the past had to create buildings that addressed their climate zone or else survival through a harsh winter or an extremely hot summer might not be possible. In addition, commercial industries of the past were dependent on specific climate conditions which in turn began to define the region's character. Today, due to mechanically conditioned spaces and other social factors, buildings designs have become independent from their natural environment and forgotten many of the important 'green' building techniques of the past. New environmental problems exist today which have increased the demand for sustainable building and lead to the invention of 'green' technologies such as green roofs, solar panels, and water collection and storage systems. Modern architects should use these technologies in their design schemes to demonstrate a return to a dependency on the natural environment.

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1. Central Proposition

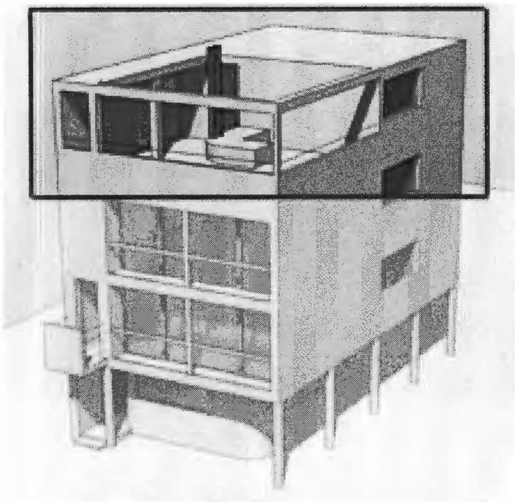
Sustainable architecture has become a necessity in today's society as the world's natural energy sources continue to deplete. At the same time suburban sprawl and housing developments which could be built in any part of the country have resulted in a loss of regional expression in architecture. Architectural design was once driven by the surrounding regional climate and site which resulted in its own unique appearance, yet this expression and spirit of connection to the environment has now been lost due to many social factors and the creation of mechanically conditioned spaces. This offers a prime opportunity for the creation of a new type of architectural expression that not only addresses environmental issues, but also is a reflection of a region.

"Humans primary means of providing themselves with comfort in the natural environment lies in creating their own protection using clothing and buildings. Around the world, people have developed energy-efficient building forms that are suited to the climatic conditions of their particular location - a sort of solar vernacular. They have developed simple yet cleverly built solutions to the environmental challenges set before them, whether by heat, cold, rain, or wind. These solutions have, of necessity, been developed using only a limited range of indigenous building materials, all of them renewable." (Behling 44). This use of indigenous material along with building forms that defined a type of 'regional' architecture has been lost, and therefore the concept of a regional architectural expression has also been lost. Through a rediscovery of sustainable design techniques of the past combined with modern technology of today, a new regional architecture can be achieved in the Southeast United States all the while addressing the environmental concerns of modern society.

Defining Expression

Expression in architecture is a much deeper and complex concept than simply 'how a building looks.' Expression is a property of architecture that actually moves a person emotionally. It excites the senses of the inhabitant and conveys ideas of order and understanding. There is a physiological element that immediately affects the viewer through the combination of forms whether they be cubes, spheres, or lines. Le Corbusier describes architecture as ‘a pure creation of the spirit’, and this concept should resonate within the conscience of every architect and should be reflected in the appearance of his or her designs. If architecture is a reflection of the spirit then there must be an issue morality involved in an architect’s designs. The expression of a building should reflect the designer’s beliefs whether they be ethical, religious, social, or environmental. The designer must consider the building’s place, time, and surroundings all of which can inform design decisions resulting in a form that ‘rewards the desire of eyes’ (Le Corbusier 16).

“Architecture is a thing of art, a phenomenon of the emotions, lying outside questions of construction and beyond them. Architectural emotion exists when the work rings within us in tune with a universe whose laws we obey, recognize, and respect. (Le Corbusier 19)” Architectural emotion does takes on a deeper meaning than just a feeling a person gets inside a building, yet this concept must exist within the realm of construction methods and materiality. Le Corbusier’s design process was a holistic approach considering many social factors where the end result was a building that was as complex and as simple as ‘the laws of the

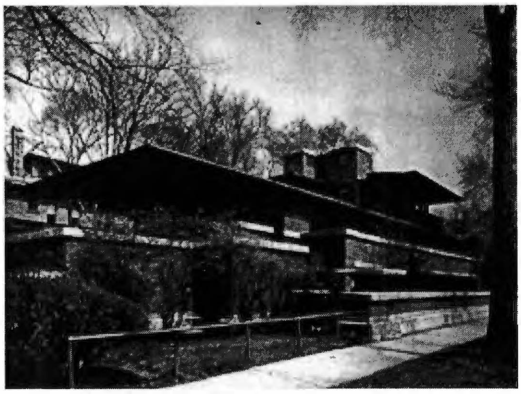

(Fig. 1) - Citrohan House


(Fig. 2) - Villa Savoye

universe'. For example, Le Corbusier's simple roof gardens and terraces were in direct response to the complex problems of the declining health of overcrowded cities that had limited outdoor spaces (Fig. 1). The same concept could be compared to the process and need of sustainable design today as the environmental issues become a greater concern of society. In addition, the expression of Le Corbusier's villas (Fig. 2) was one of hygiene and cleanliness which was an 'answer' to a greater problem. In the same way, the expression of a sustainable building should be one that addresses a greater problem of today, which is not only the global environmental issues but also the concepts of a lost regional expression in architecture. The end result is a type of architectural expression that resonates feelings of appropriateness and morale.

"We have gained a new perspective and a new social life, but we have not yet adapted the house thereto. (Le Corbusier 16)" Even though this statement from Le Corbusier was delivered in the early 1900s it still remains true today. Le Corbusier recognized that social life was changing rapidly due to the industrial revolution. Cities became over crowded and physical health of the population began to dwindle. As a result Le Corbusier proposed a new 'type' of housing and therefore a new expression. The same proposal can be made in today's world. Americans have become increasingly wasteful with water, energy, and natural resources and the general public has become used to simply throwing their trash in a can without any thought as to the long term consequences. Similar to Le Corbusier's proposal for housing to adapt to the new society, architects should design in a manner that reflects both the modern society as well as environmental concerns, both of which are interwoven.

"Architecture is organic when the spatial arrangement of room, house and city is planned for human happiness, material, psychological and spiritual. The organic is based therefore on a social idea and not on a figurative idea. We can only call architecture organic when it aims at being human before it is humanist (Zevi 76)" The concept of architecture being organic was developed by Frank Lloyd Wright whose houses reflected landscapes of the plain states as well as trees rising from the earth with branches expanding outward to the


(Fig. 3) - Robie House

sky (Fig. 3). Organic architecture should be designed for human happiness which one could argue is a complement to the expression of a building as well as the comfort of a building. To build in such a way would require a designer to examine not only the physical qualities of the spaces (materials, sizes, etc.), but also the psychological and how these items effect the human spirit. Sustainable design is the same concept. Material choices, site location, and building orientation are all important physical choices to make when designing for a particular climate, but in conjunction with these choices comes the appearance and quality of the project that ultimately define the expression. This type of 'sustainable expression' is one that has not come to fruition yet, but will advance through the combination of continued development in 'green' design technologies along with sustainable design techniques of the past.

"The architectural expression of the early pioneers of sustainable architecture have already suffered the slings and arrows of harsh criticism for their style and expression, but within their ranks are many who are finding the keys to unlocking the riddle of harmonic inclusion of the necessary technologies within the shell or frame of an inspirationally beautiful edifice." (Joyce 15). Sustainable architecture of the 1970s typically dealt with the incorporation of environmental technology and not necessarily how they might become part of the total design. Therefore, the architects who concerned themselves with these practices fell to harsh criticism even though their intent was a positive one. Architectural expression was not a major concern which left many of these buildings to become 'forgettable' structures. Architects of today should note the criticisms of the past to create a new expression that achieves both a high level of sustainability as well as an appropriate design appearance.

Environmental design has begun to take the path of ADA regulations during the 1990s. Where new furnishings such as wider doors and various handrails were invented, the role of designing for these codes did not create the type of awareness and social message that was possible. Instead an opportunity was missed and these ADA issues were viewed as obstacles to work around. Eco-sensitive architecture needs to make an impression on the public through its expression if it intends to last. "Just because a building makes only a faint impression on the land, doesn't mean it


(Fig. 4) - Ice House warehouse conversion (before)


(Fig. 5) Ice House warehouse conversion (after)


(Fig. 6) - Cantileiver barn

needs to make a faint impression on the eye" (Hawthorne 122). One only needs to point to the preservation of buildings which are considered precious icons by the general public because they reflect the local culture or region. Many old warehouses and factory buildings have been revamped for housing which addresses the sustainable issue of longevity, but their shells have been allowed to remain because of their appearance (Fig. 4 & 5). Arup McGregor believes that, "a building can use the most recent environmental technology, but if nobody enjoys the building then it is not sustainable (Hawthorne 123)".

The idea of a 'sustainable expression' of a building should be inherent to the region the building exists and on a smaller scale, the site. The East Tennessee region is one that has varying topography and is lush with vegetation. A building's incorporation of the landscape and local vegetation will become part of the building's expression, such as through the use of local timber as a skin. Yet, the expression of a building should also reflect some of the more common structures in the region that are considered part of the culture, such as the cantilevered barns (Fig. 6). A designer could easily draw sustainable techniques from these common buildings, but it would be difficult to ignore modern technology that should be used in the design to improve up the climatic design strategies of the past. These new 'green' strategies that apply to environmental concerns of a specific region should be incorporated into the design scheme. In this sense the combination of the past and present a building will take on a viable vernacular that is specific to its climate region and site location.

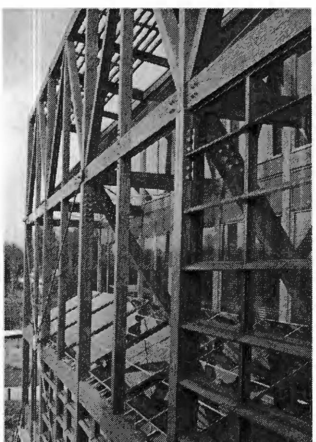
2. Precedents


(Fig. 7) - Phillip Merril Enviromental Center

Phillip Merrill Environmental Center– Annapolis, Maryland by SmithGroup. Inc.

The Phillip Merril Environmental Center (Fig. 7) is the headquarters for the Chesapeake Bay Foundation which is the largest conservation organization dedicated to saving the Chesapeake Bay. This building the USGBC's first LEED certified project to receive its highest ranking of 'platinum'. This project was completed in 2000 and is considered to be one of the energy efficient buildings in the world. Even though this building has achieved high level of sustainability, what is more interesting is the quality of architectural expression achieved by the use of 'green' technologies throughout the project. On the entry facade three large wooden barrels dominate the elevation but coexist fittingly with the rest of the building (Fig. 8). The architects choose not to simply conceal these water storage tanks, as most designers would for a HVAC system, but rather incorporate them as an expression of the building itself. Also, the use of structure and photovoltaic cells are incorporated into the design scheme as well (Fig. 9). The PV cells are interwoven into the exposed wooden structure which


(Fig. 8) - Phillip Merril Enviromental Center with cisterns revealed


(Fig. 9) - Phillip Merril Enviromental Center structure with PVs

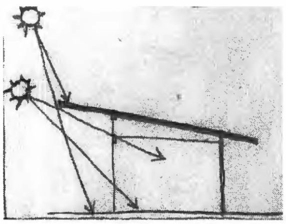
become a symbol of the past and the present. Where the age-old timber framing technique is embracing the new 'green' technologies to create an expression that speaks to both the ancient and the contemporary.


(Fig. 10) - Fletcher/Page Residence South elevation

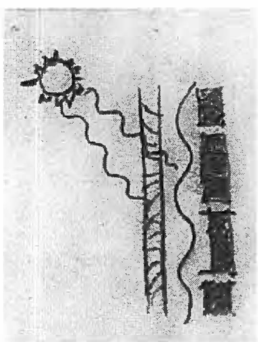

(Fig. 11) - Fletcher/Page Residence

Fletcher/Page Residence - Kangaroo Valley, Australia by Glenn Murcutt

The Fletcher/Page residence (Glenn Murcutt) in Kangaroo Valley, Australia is a house that reflects and reacts to the surrounding climate conditions and landscape (Fig. 10 & 11). "The important thing that is the process of construction should always be a process of deconstruction." - Glenn Murcutt. Murcutt believes that the environment is more precious than any structure standing on it, and this environmentally conscience house can be completely dismantled, removed from the site and the components can be reused (Hay 60). Murcutt charted the sun, wind, and rain before design which helped Murcutt decided on the size of window glazing, overhangs and rain collection technology. The architect combines the tenets of modernism with the structural forms found in nature.



(Fig. 12) - Fletcher/Page Residence sunlight diagram



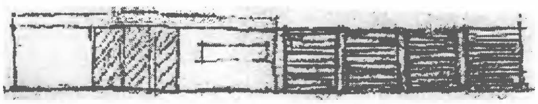
(Fig. 13) - Fletcher/Page Residence wall diagram

Past environmental techniques

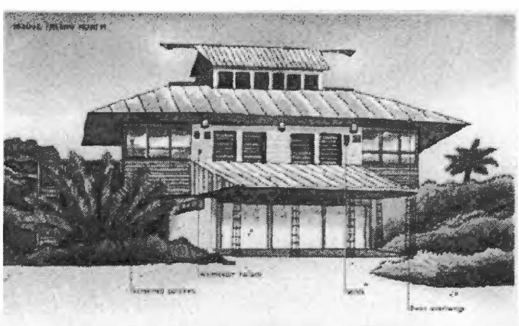
Through the simple use of large overhangs the house takes advantage of the direct sunlight in the winter and blocks it in the summer (Fig. 12). The general construction materials used are also environmentally responsive. The use of local timber is on the outside, then insulation, then brick on the interior which resist the transfer of heat, and in the winter these same walls retain the heat inside (Fig. 13). The techniques of using thermal massing to retain heat and large overhangs for controlling direct sunlight has existed for decades, yet it is easily adaptable in a contemporary house such as the Fletcher/ Page residence. The overhangs and the use of local timber on the exterior of the house convey a type of expression that relates to the past and the surrounding environment.

Modern environmental technology

The design can be described as nature-responsive yet grounded in modernism. This combination of environmental design techniques and modern technologies creates an expression that creates a connection to the landscape and local climate. Murcutt achieves this expression through ideas such as the electronically controlled shutters that



(Fig. 14) - Fletcher/Page Residence elevation diagram



(Fig. 15) - Palmetto House

track the sun, which are inspired by the local eucalyptus leaves than turn with the sun path to reduce transpiration. Since Australia's climate typically has a wet season and a dry season, water collection is a necessity in the rural parts of the country. Murcutt addresses this age old problem with a very modern solution as rainwater runs off the roof and into four corrugated iron tanks for storage and purification (Fig 14). Through the placing of operable windows on both sides the house promotes natural ventilation and portrays the feeling of lightness as one could imagine the clouds go straight through the house.

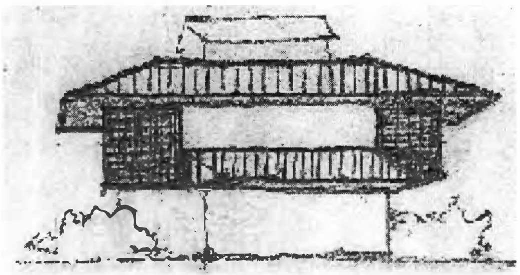
The corrugated tanks work in proportion with the modern residence and become part of the whole design. These corrugated tanks also create a vernacular because the house sits in a part of the country where these tanks can typically be found, but used in different ways. The large movable glass doors on the house also contribute to the expression of the residence, as there is a constant view out to the landscape.

Palmetto House - Miami, Florida, by Jersey Devil Architects.

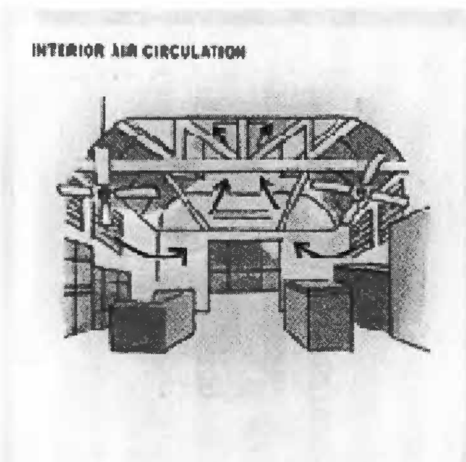
The Palmetto House (Fig. 15) in Miami Florida is an example of a residence whose local vernacular deals with the climate zone through a variety of passive cooling techniques. The house takes sustainable ideas of the past and combines them with modern technology to create an expression that is appropriate for the Florida region.

Past environmental design

The Palmetto House uses simple passive cooling techniques such as large over hangs and strategically placed porches that are reminiscent of 'cracker houses' from early pioneers in the Florida region. These deep shadowy eaves and large screened porches at either end allow southeasterly breezes to blow through the entire home (Fig. 16) and then expell the air up and out the upper level (Fig. 17). There is no mechanical air conditioning system in the entire home, yet through the passive cooling techniques mentioned above along with the 12 electric ceiling fans occupants feel very comfortable (Lantigua 65). Even the technique of the building's orientation of North/South is in relation to the path of the sun is a technique of ancient building. The fact that this house does not incorporate mechanically conditioned spaces creates a reflection to the past building designs where HVAC

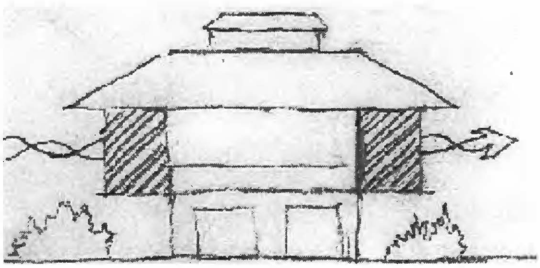


(Fig. 16) - Palmetto House - large eaves and porches



(Fig. 17) - Palmetto House - air flow

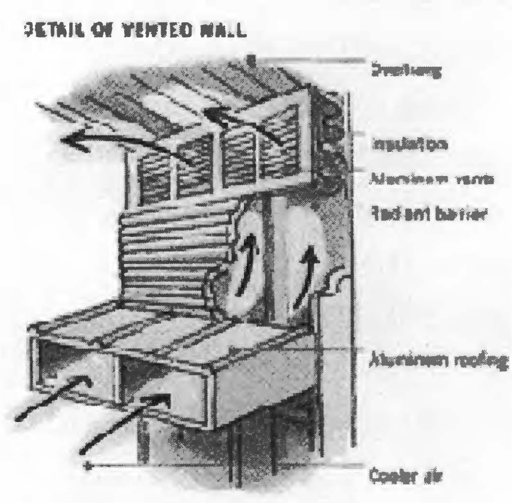
systems did not exists and passive cooling techniques had to be used. Therefore, the expression of the house must relate to the local climate. The screened in porches used as buffer zones and long overhangs of the house are both expressive design techniques that have existed since pioneers came to the Florida region, yet they still can exist today in a contemporary home.



(Fig. 18) - Palmetto House - raized living floor

Modern environmental technology

Jersey Devil's response was a kind of space age cracker house which uses corrugated aluminum façade and roof, that reflected much of the hot Florida sun along with a sleek angular appearance. Pioneer houses in this region were only one story, but the architects instead place the living spaces on the second floor to take advantage of natural breezes as the higher space off the ground (Fig. 18) (Lantigua 68). The house design traps heat in the roof and wall before it can permeate the living space and expels it through a series of vents on the top two floors. The architects incorporated a radiant barrier ventilation system within the walls (Fig. 19). The vents of this system, similar to the corrugated water storage tanks in Murcett Fletcher/Page residence, are part of the expression of the house. An



(Fig. 19) - Palmetto House - wall system uninformed viewer may not understand the function behind these large exposed vents on the exterior facades, but they appear to be in harmony with the rest of the house. In addition the reflective material chosen for the roofs and exterior walls also create an expression unique to the region. The standing seam roof becomes part of the building's viable vernacular, because it not only reflects heat as many of the older houses in that area but it also provides a space for solar panels which provide hot water and power to the home (Fig. 15). (Lantigua 69).


(Fig. 20) - Kropach / Catlow Residence

Kropach/Catlow Residence – Myocum, Australia by James Grose

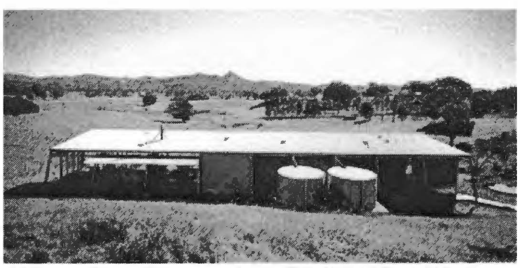
Grose – "This house demonstrates that you can interact with, rather than impose yourself on, the natural landscape".

(Fig. 20) Located in a subtropical climate roughly 100 miles south of Brisbane this residence is an example of using economical materials to create a modern language that respects the landscape. The construction is one of steel and glass (Fig. 21), which is well suited for this type of climate, and its vernacular language is characterized by the bolted steel frame and softly burnished metal cladding. (Hyatt 149).


(Fig. 21) - Kropach / Catlow Residence - South elevation

Past environmental design

Its repeated elements and simple rectangular form and light steel construction lend itself to a more economical budget (Hyatt 149). The use of light construction can be found in most ancient buildings in the subtropical climate zone. What is uncommon in the Kropach/ Catlow residence is that the material used for construction is not wood, but rather steel. This design creates a reflection of the past, but yet it is inherently modern as the steel structure is used in a similar context as if local timber had been used. As seen in other primitive design techniques the roof-line is shaped to shield the summer sun and capture the winter sun (Fig. 22). In addition through the use of highly reusable materials the building can easily be taken down and put up again without any indication that it had been on the landscape (Hyatt 153). This concept of being able to easily take down a building has a definite connection to the landscape and surrounding environment because the building must be of very light construction as well as unimbedded in the ground. This light construction creates an expression that is appropriate for that climate region.



(Fig. 22) - Kropach / Catlow Residence - entry and cisterns

Modern environmental technology

The elevated floor and sliding windows and walls become part of the expression of the house as they blur the inside-outside experience and also allow for more access to natural ventilation (Fig. 23). These sliding glass doors and walls allow for optional comfort during both the hot and cool seasons. These glass louvers become the dominant architectural element in the project as they create the interior atmosphere by generating cross ventilation as well as access to natural light.

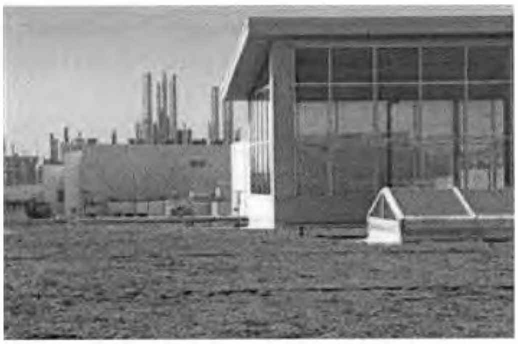
(Fig. 23) - Kropach / Catlow Residence - interior

Ford Rouge Revitalization Project – Dearborn, Michigan

This new truck assembly plant represents an effort made by Ford to rethink the ecological footprint of a large manufacturing facility. The design synthesizes an emphasis on a safe and healthy workplace with an approach that optimizes the impact of industrial activity on the external environment. The overwhelming environmental response is the plant's 454,000 square foot green roof, which is the largest in the world (Fig. 24). This massive green roof makes a statement towards the future construction and design. The Ford plant's green roof along with its contrasting metal siding and

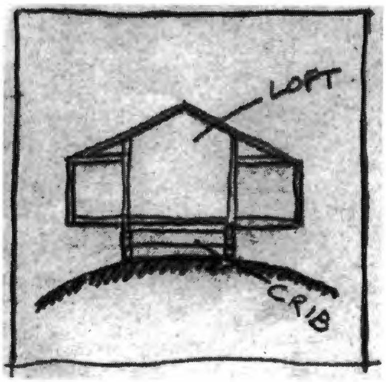
(Fig. 24) - Ford Rouge Revitization project large factory-like glazing (Fig. 25 & 26) create's an expression that is inherently of that region. Since Michigan is known for car manufacturing and its large assembly plants, it is appropriate that the Ford corporation design a building that is considered to be the 'new' automotive plant. With its gigantic green roof and other sustainable features of the complex this project is an example of building type and program that reflects the region as well as its environmental response to the climate.

(Fig. 25) - Ford Rouge Revitization project - green roof 1

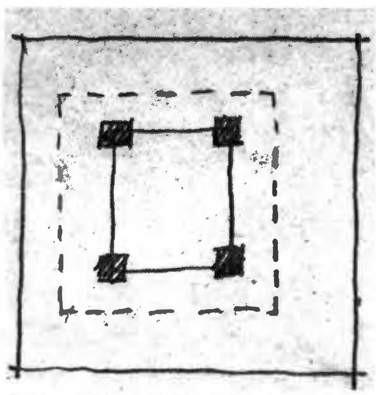

(Fig. 26) - Ford Rouge Revitization project - green roof 2

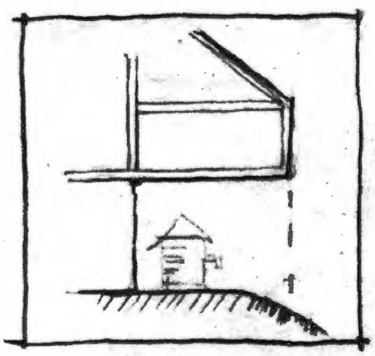
3. Case Studies: Sustainable qualities of the past in similar climate zones

Regional architecture was once defined by the climate in which people existed. The architects and builders who created these dwellings of the past had to use 'green' techniques because their survival depended on it. Authors such as Klaus Daniels and Stefan Behling divide the world's countries into roughly 8 - 11 separate climate zones based of similar characteristics. States such as Tennessee, Kentucky and Georgia are considered to be in the Subtropical and Temperate Climate Zone. In this zone most of the year the climate is pleasant with a short winter, but summers are very hot and humid, so quality ventilation must be incorporated in order to avoid over heating (Behling 42). Other areas whose builders developed different solutions to the same problem of the subtropical climate zone include Japan, parts of Asia, and Northern Africa. The modern architect should look to these age old solutions in order create sustainable buildings and also a new expression according to its specific region (Daniels 47-49).



(Fig. 27) - TN catilevered barn - general structiure

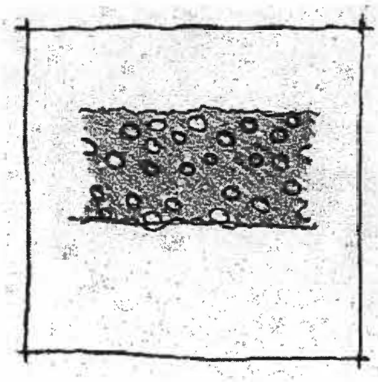

(Fig. 28) - TN catilevered barn - corner foundation stones


(Fig. 29) - TN catilevered barn - dry storage for equipment and dry ground

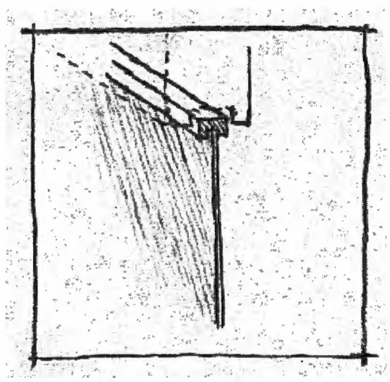
Materials and Skin

The cantilevered barns of Eastern Tennessee are an example of regional architecture that was designed with the surrounding climate as the main concern. The landscape of the region is typically hilly, rocky, and heavily forested, and these material qualities became part of the structure. The basic structure of these barns was a unchincked crib base with a wood frame upper story made of local yellow pine (Fig. 27). Since the soil tends to be damp in this region the foundation of the barns were flat stones laid on top of each other and only set at the corners of the crib (Fig. 28). This type of foundation also benefited the movement of barn if it needed to be taken down and relocated. Through the use of the cantilever the structural logs on the ground level were kept dry which combat rotting while also allowing for a dry space to store equipment (Fig. 29). The dry ground provided by the cantilever also deterred termites that need wet soil to survive (Fig. 29) (Moffett 46-48).

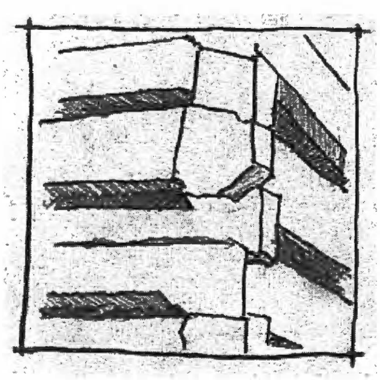
For centuries in Japan houses have adjusted to the climate in its own way along with careful consideration to views to create a unique expression. Thermal mass was utilized through local materials such as packed mud combined with straw



(Fig. 30) - Ancient Japanese housing - straw and bamboo



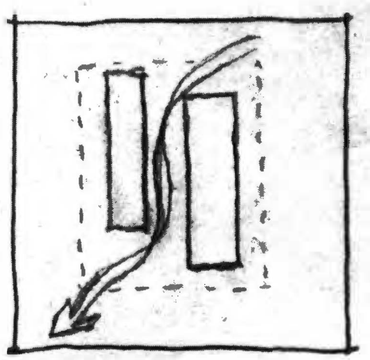
(Fig. 31) - Ancient Japanese housing - rice paper walls



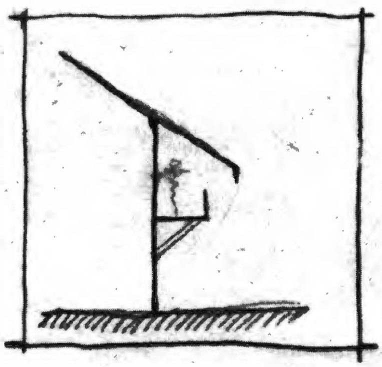
(Fig. 32) - TN cantilevered barn - unchincked construction

and bamboo lattices, which also offered structural reinforcement and framing of doors and windows (Fig. 30) (Behling 58). Layered rice paper was used in the sliding doors which provided alternate floor plans and complemented the light construction of these houses (Fig. 31).

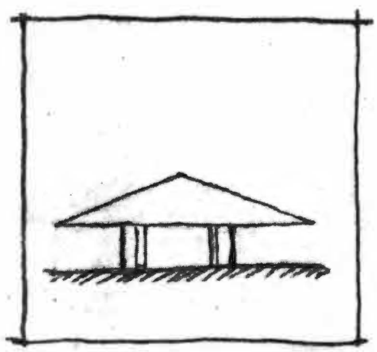
The use of material in both the East Tennessee Cantilevered barns and ancient Japanese houses can be incorporated into modern regional building techniques. Not only can the specific type of wood used in the cantilever barns be used in a building in Eastern Tennessee but also the way the material is shaped and attached together (Fig. 32). This attachment creates an expression that is unique to the barns constructed in the early 1900s, and can be used as a vernacular architecture if the same construction method and materials are used today. In Japan the same materials are still used in modern construction. Through the use of local materials a certain expression emerges that is inherently Japanese. The same concept should apply to the various climatic regions of the United States in that the local materials appear to be in harmony with building, the landscape, and the region.



(Fig. 33) - Early United States pioneer house - breezeway



(Fig. 34) - New Orleans house - covered porch

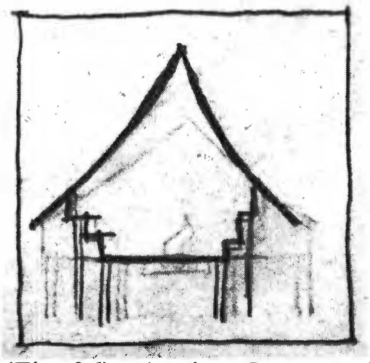


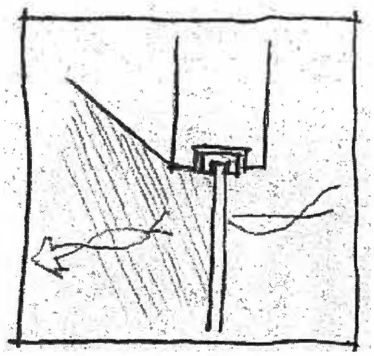
(Fig. 35) - Early Southeast United States pioneer house - large overhangs

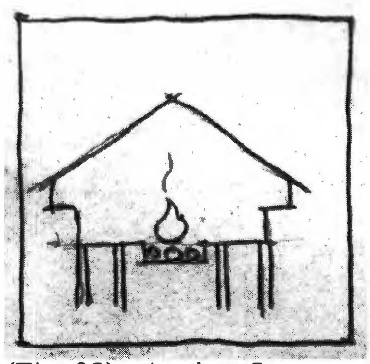
Natural Heating and Cooling

The cantilever barns were also efficient in keeping livestock cool during the hot summer months through its large over hangs that provided shade. In addition, many pioneer houses in the southeast United States used the concept of the breeze-way which can be found in the two-crib cantilevered barn (Fig. 33) (Moffett 46-48). By designing an opening between the two sides of a the house a positive and negative pressure is created for wind flow.

As settlers came to America a new type of architecture needed to be created to adjust to the unfamiliar climate. A type of 'architectural compromise' was invented between buildings of their own culture while attempting to conform to a new climate (Behling 59). Unfortunately the results were not as efficient as, for example, the Japanese who have dealt with the same climate for centuries and found very effective ways of creating natural comfort. However, the new settlers understood the need for shaded spaces and buffer zones as seen in the numerous covered porches in New Orleans (Fig. 34) and the large overhangs found in the 'cracker houses' of early settlements in Florida (Fig. 35) (Lantigua 67).

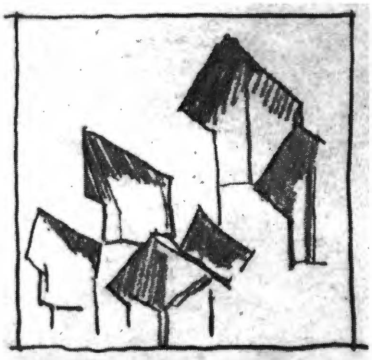

(Fig. 36) - Ancient Japanese housing - large operable overhangs


(Fig. 37) - Ancient Japanese housing - poor winter insulation

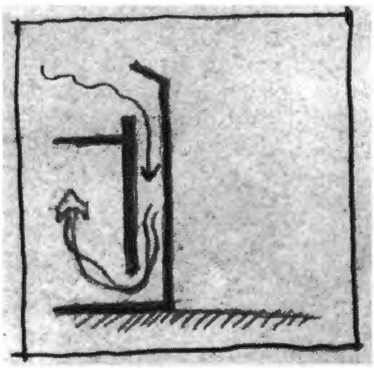

(Fig. 38) - Ancient Japanese housing - winter heating source

Parts of Asia and Japan are considered to have more advanced means of natural heating and cooling due to their long history of dealing with the subtropical climate zone (Behling 59). Keeping the sun out of the house during the summer months and letting the winter sun in was also a concern of the Japanese. They solve this problem by using steep roofs with large overhangs on the south facades (Fig. 36). In addition these large roofs kept the solar radiation out of the house and were typically made of thatch which prevented overheating in the house through evaporative cooling (Behling 58). Rice paper panels were also used to control heating and cooling. An unfortunate result of the thin movable panels in traditional Japanese housing is the poor insulation qualities during the winter months (Fig. 37) (Daniels 49). This is a common problem involved in most ancient buildings in the subtropical climate zone, where one would sacrifice a warm winter for a well ventilated and cool summer (Behling 59). A typical solution was a single fire pit in the center of the home where the family would gather around (Fig. 38) (Daniels 49).

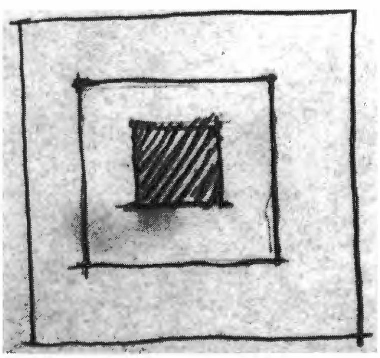
Parts of North Africa also are considered to exist in the subtropical climate zone and their means of cooling,



(Fig. 39) - Town of Hyderabad operable wind catchers



(Fig. 40) - Wind catcher wall for passive cooling



(Fig. 41) - Courtyard space

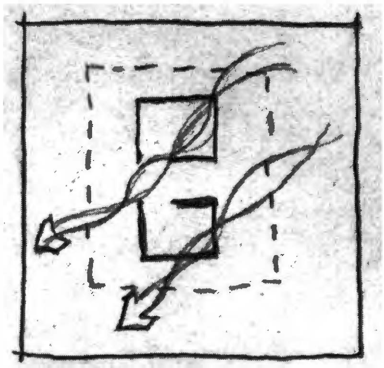
although different than what is found in traditional Japanese houses, is equally as successful. In the town of Hyderabad operable wind catchers grab the cool afternoon breeze which comes from the Northwesterly direction (Fig. 39). As the air travels down through the walls it takes on moisture and is expelled to the interior spaces (Fig. 40) (Daniels 48). These diamond shaped wind towers not only serve a very important cooling strategy, but they also become a symbol for the town and the region.

Courtyards also are typically found in Northern Africa where the outside temperature can become extremely hot. The courtyards create a type of micro-climate where the air is cooler creating a comfortable space to occupy (Fig. 41). These open courtyard buildings not only provide a place where a human can escape from the scorching heat, but they also allow for a communication link through the building itself (Behling 58).

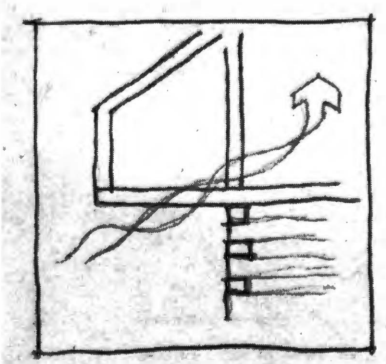
Many of these ancient natural heating/cooling techniques have been lost over time predominately due to the invention of mechanically conditioned spaces. Yet, these techniques can and should apply today. For the subtropical climate region it is necessary to create positive and negative pressure zones, similar to the dog-trot, to promote cross ventilation during the summer months. The Japanese with their thin movable walls that controlled amounts of direct sun light and wind flow is a concept that can be applied to any of the subtropical regions. But in addition to this technique a modern day design should address the insulation problems with the thin wall construction. The idea of the wind catchers in Hyderabad is not only about using the natural environment to cool a building, but it is also dealing with the concept of a symbol. The image of the wind catchers creates an aesthetic that speaks to the concept of not only the region but also that town. The fact that those icons could function in only a few parts of the world creates a type of uniqueness specific to that town. This 'uniqueness' should be expressed in modern sustainable architecture as well. If a designer's process is driven by the surrounding environment then inevitably the result should be a form that is specific to that climatic region.

Natural Ventilation

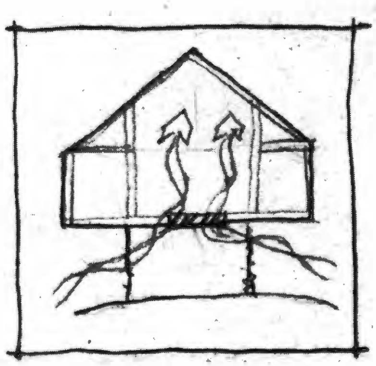
The barns of eastern Tennessee were extremely efficient in keeping natural ventilation flowing through the structure.



(Fig. 42) - TN cantilevered barn - open floor plan



(Fig. 43) - TN cantilevered barn - open eaves for natural ventilation



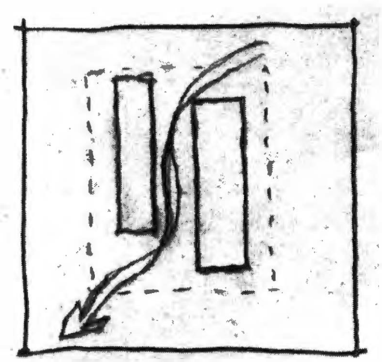
(Fig. 44) - TN cantilevered barn - 2nd storyaccess as stacked ventilation

The typical open floor plan (Fig. 42), unchincked construction, open areas at the eaves (Fig. 43), and a type of air chimney created by the access to the loft (Fig. 44) all promoted the flow of air through the building (Moffett 46-48). This air flow kept crops dry that were stored in the loft and the cribs of the barn.

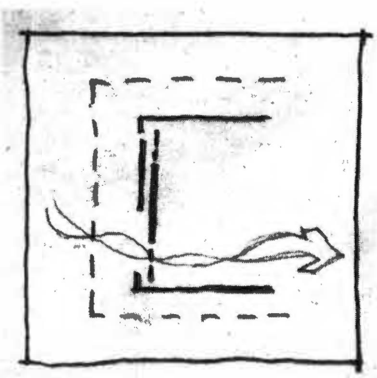
The 'shotgun house' which can be found across the Southeastern United States uses the concept of the dogtrot to allow for cross ventilation through building and site (Fig. 45). As long as the house is oriented correctly to the predominate summer wind, air flow can reach both living units through the long opening that separates the floor plan.

Screens and sliding doors of ancient Japanese houses were used to promote cross ventilation as well as a buffer zone between indoors and outdoors (Fig. 46). Most of these housing units were kept at single story and raised off the wet ground to increase ventilation (Fig. 47) (Behling 58).

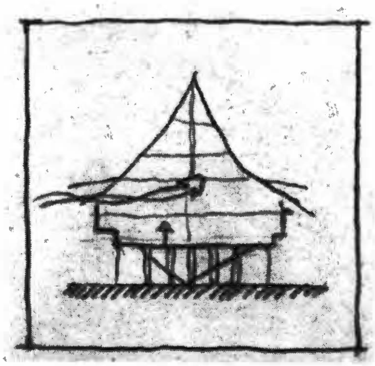
These natural ventilation techniques can be used today to allow for fresh air into the building and



(Fig. 45) - New Orleans shotgun house
- cross ventilation



(Fig. 46) - Ancient Japanese housing
- movable screen doors buffers



(Fig. 47) - Ancient Japanese housing
- 1st story off ground

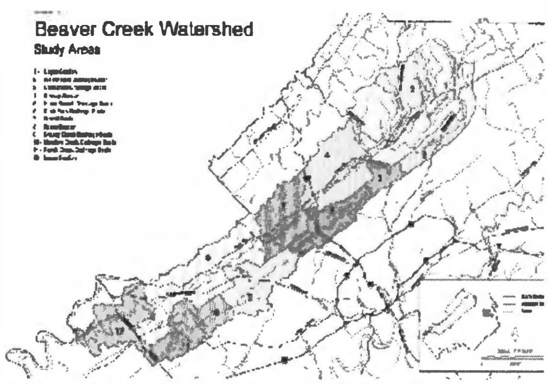
prevent moisture gain. However, they should be improved upon with modern technology that will allow for air flow without losing insulation properties. These techniques create openings at strategic points in the form of the building and therefore effect the expressive qualities of the building. Yet, it is important to note that typically the function of these openings is not only to allow for ventilation. They also allow for entry ways, circulation, sun light, and access to all sides of the building.

4. Conclusion

Even though builders in Southeastern US, Northern Africa, and Japan all had to deal with the same subtropical climate zone, they each successfully solved the problems of their climate in different ways. In the process their solutions created a regional appearance that reflected the natural resources available as well as their control the natural elements. It is important in today's world of depleting natural resources that architects look to the past to find simple, yet efficient ways to build sustainably. This is not to say that emotion and passion for architectural expression should be cast aside in the name of sustainability. These 'green' design techniques should be considered as 'additional paint on the designer's palette' to create a work of art that reflects the society of modern culture. There is a moral issue that exists in architecture today where an architect has the ability to make decisions that effect more than just financial budgets and the general appearance of a project. The modern architect must address concerns of the natural environment which in turn will create a powerful new expression that invokes emotional questions of why to build in this manner. Finding a formal language for green architecture that reflects both the modern technology and the simplistic techniques of the past is the challenge for today's architect.

5. Building Type - Distillery

Distilleries have a unique connection not only to the history of Tennessee, but also to the region's climate and landscape. Distilleries have existed in the Tennessee area since the 1800s and have become an industry that is specific to the region. This connection to the region is similar to how the automotive industry is inherently part of the culture and history in Michigan. Historical distilleries required environmental elements that were part of both the area's climate and also specific to the site itself. Most distilleries are located in rural locations and tend to be stand alone buildings. Some require their own natural water source such as a spring or well of which the chemical content will have an effect on the quality of the distillery's final product. For example, both the Jack Daniel's distillery in Lynchburg, Tennessee and the Maker's Mark distillery in Loretto, Kentucky both rely on natural springs with low iron content. Since the Beaver Creek area in Knox County has a high concentration of water a distillery would be an appropriate building type due to its dependance on a water source. In addition, the process of making spirits is well connected to the availability of local materials. Eastern Tennessee timber such as maple and oak are used to create both charcoal for the melowing process as well as barrels for the aging process. Other distileries construct their large fermentation vats out of cypress found in the swamps of the Southeast United States due to their water ristant qualities. The region's seasonal changes are also important during the aging process, where the varying climate will cause the wooden barrels to expand and contract giving the spirit a certain color and taste. Distillering is an industry that is dependant on a climate with varying seasonal temperatures, access to water, and local material for its production, and the Knox County region provides these requirements. Similar to the Ford Rouge Plant in Michigan, this building can create a new sustainable expression for a building type that is not associtated with enviromental concerns.



(Fig. 48) - Beaver Creek Watershed

6. Site

Location: Beaver Creek Watershed, Knoxville, Tennessee

The Beaver Creek Watershed (Fig. 48) is located in North Knox County and is approximately 3.5 miles wide and 25 miles long. The area is characterized by a broad floodplain with rolling hills between two ridges. The Beaver Creek was considered to be polluted and uninhabitable for aquatic life in the late 1990s. This area is considered to be the fastest developing area in the county and as a result flooding has increased due to the amount of impervious surfaces. There is a Green Infrastructure plan in the formation stages specifying areas that can be used for development and those designated for conservation.

Site Criteria - The site should be in a rural location, but within close proximity to a city or town. Access to sunlight and predominate wind directions is required. Access to water - either a stream or natural spring. Timber for material needs to be within the region. Climate should be in a range of temperatures according to the seasons.

7. Program

Quantitative:

Visitor Center & Store	3,000 SF
Grain Grinding & Milling	1,000 SF
Mash Tub Area	800 SF
Fermenting Area	1,200 SF
Still House	1,000 SF
Charcoal Filtering & Filling	3,000 SF
Barrel House	7,500 SF
Bottling Area	700 SF
By-Product Storage Area	1,000 SF
Rick Yard	1,000 SF
Grain Storage Area	840 SF
Office, Break, & Bathroom	2,500 SF
Crop Equipment Storage	1,000 SF
Mechanical Room	1,000 SF
Building	29,500 SF
Parking	6,000 SF

Qualitative:

The building that is proposed shall be one that is an expression of the subtropical climatic region and will convey a feeling of environmental conscience for the visitor and occupant. Through the general form of the building and exposed sustainable technology a visitor to this building will begin to ask questions of the project where the answers will be an environmental response. Using local materials from the east Tennessee region the structure will express a sense of appropriate place and connection to the surrounding landscape. The public rooms would be filled with natural light and the amount of direct sun light would depend on the seasons. The north facade of the building will have a large amount of glazing to let in a consistent amount of natural light, while the south facade will be protected by outdoor porches and overhangs appropriate for the sun angle at this region. Inside the building a visitor would feel curiously comfortable as the mechanical heating and cooling system is rarely used. Through the use of an open floor plan and spatial dividers that allow for ventilation a person would easily flow through the public spaces. The materials on the interior would reflect the exterior in a way that is reminiscent of the past.

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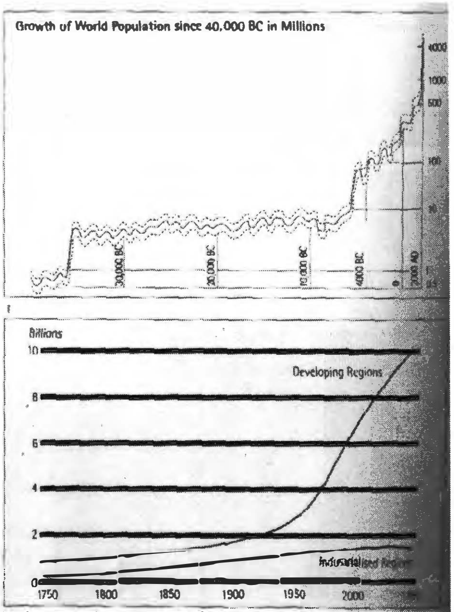
APPENDICES



(Fig. 49) - Population Increase

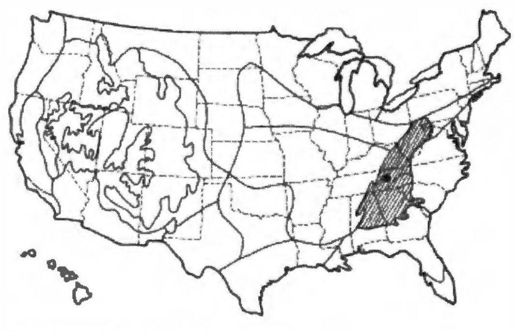
Why move for sustainable design

Today's society is at the beginning of a 'post industrial revolution' dealing with various global trends that radically alter human life on the planet. Some of these trends include population growth, environmental pollution, and resource exploitation. The population of the planet is expected to double by 2050, from 5.7 billion (1996) to 10 billion people, and this increase will mainly be the result of today's developing countries (Fig. 49) (Daniels 10). In the United States CO2 emissions are at an all time high and show no signs of slowing all the while Americans are using 32% of the world's total energy consumption while only occupying 5% of the world's population (Daniels 16). Even the Earth's temperature has changed as a result of air pollution. CO2 levels have increased from 289 ppm to 350 ppm over the last 130 years due to carbon dioxide emissions, combustion of vegetation for land clearing, and other air polluting gases (Daniels 17). Prior to the industrial revolution natural resources used for the creation of energy were as exploited as they are today. With a large increase in population leading to more building and demand for energy it is apparent that our natural resources will become exhausted and a new manner in which we build and live must come to fruition.

Environmental issues such as water and energy conservation are not exclusively tied to the construction of large scale buildings, but they are also issues of concern on the level of residential building. Today 56% of potable water consumed in private households could be replaced with grey water. Toilet flushing, which consumes a third of all potable water, as well as watering, cleaning, and laundry could all be replaced with grey water. Only food consumption, dish washing, and hygiene require potable water (Design Principles 56).

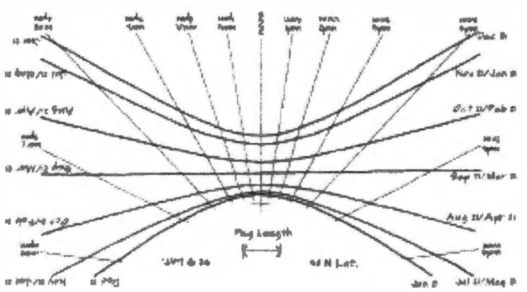
In the U.S. alone nearly $16 billion worth of energy is lost through cracks in residential buildings and 35% of landfills in the US are from construction debris. It is also note worthy that from 1970 to 2001 the average household size has decreased from 3.1 to 2.6, while the average house size has increased from 1,500 square feet to 2,185 square feet (Hawthorne 113).

It is the responsibility of the modern architect to recognize these issues and design in a manner addressing them. Yet, the solution to these problems is not one-sided, as the architect has two interwoven responsibilities to uphold: 1: To create a building that resolves issues of modern environmental concerns such as conservation of water, energy, and materials. 2: To design a building whose aesthetic that reflects the spirit of the region, time, and place with an inherent connection to its natural surroundings. In a society where the majority of humans spend 85% of their time indoors and half of the rest of the time in some sort of transportation vehicle, it is imperative that architects do not only concern themselves with how a building appears but also how a building conforms to its specific climate zone.



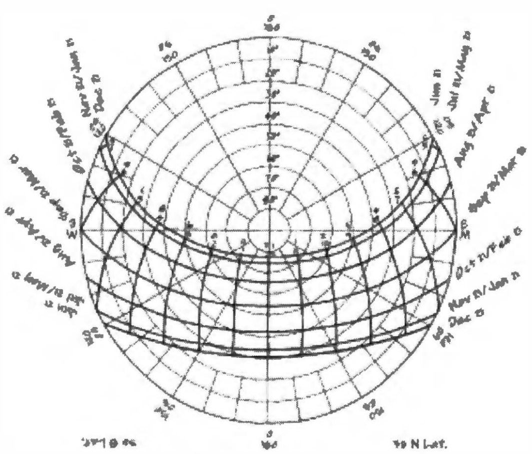
The Appalachian Zone with Knoxville indicated

(Fig. 50) - Climate zone for site



Sundial, 36° Latitude

(Fig. 51) - Knoxville sun angle tool



Sun Path Diagram, 36° Latitude

(Fig. 52) - Sun path diagram for Knoxville

Design Tool - Climatic Context for Knoxville Area

Appalachian Zone (Fig. 50) - The Knoxville area lies in the Appalachian Climate Zone which includes the subtropical ecozone. This area expands along the Appalachian Oak Forest and into the northern regions of Alabama and Georgia. It is similar to the coastal areas of the Carolinas, but its daily temperature tends to fluctuate due to the higher elevations. This area is typically temperate with very warm humid summers, pleasant spring and fall, and a mostly cool winter with chilly winds. The Appalachian Zone is typically humid all year round with average temperatures from 20F degrees in the winter and 88F degrees in the summer. This temperature range lends itself to very good night ventilation.

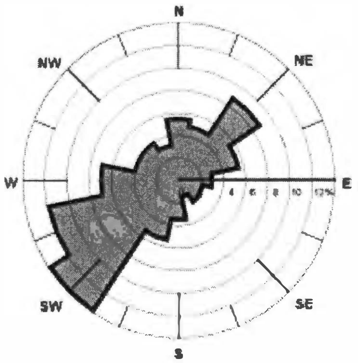
Sundial (Fig. 51) - The scale is used to track the sun's position for Knoxville's latitude (36 degrees). Along with a scale model a designer can simulate the sun's path to reveal a pattern of shade. This scale is useful in tracking shading by neighboring buildings on a particular site as well as determining appropriate shading devices and window sizing for a proposed

	J	F	M	A	M	J	J	A	S	O	N	D
1 am	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	3	5	3	0	0	0	0	0
7	0	0	2	10	23	28	22	12	6	2	0	0
8	1	7	22	40	66	70	63	62	34	21	8	3
9	19	35	65	94	120	124	116	105	92	65	37	22
10	52	73	109	135	158	175	180	150	123	108	71	54
11 am	84	104	146	178	194	206	205	192	164	144	100	81
12 noon	104	134	175	199	218	228	230	213	190	174	128	107
1 pm	117	147	185	209	211	238	230	205	174	177	129	114
2	112	139	177	218	215	229	232	219	197	170	122	109
3	95	128	166	196	200	210	210	186	167	142	56	88
4	68	95	124	157	165	172	177	146	126	100	65	59
5	37	61	91	115	120	140	134	113	84	57	29	24
6	8	22	45	64	72	89	84	69	39	15	8	3
7	0	2	9	17	28	38	36	24	7	1	0	0
8	0	0	0	1	5	8	8	3	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11 pm	0	0	0	0	0	0	0	0	0	0	0	0
12 mid	0	0	0	0	0	0	0	0	0	0	0	0

0 | 1-100 | 101-250 | >250

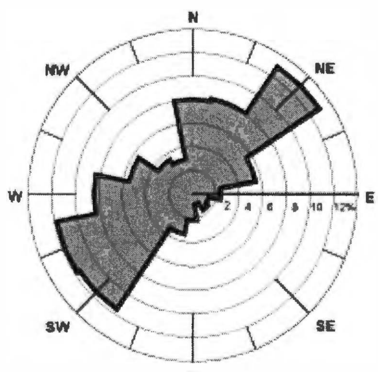
Radiation Calendar
Mean Hourly Global Horizontal Radiation (Btu/ft^2)

(Fig. 53) - Knoxville solar radiation



Wind Rose: July

(Fig. 54) - Knoxville wind rose (July)



Wind Rose: January

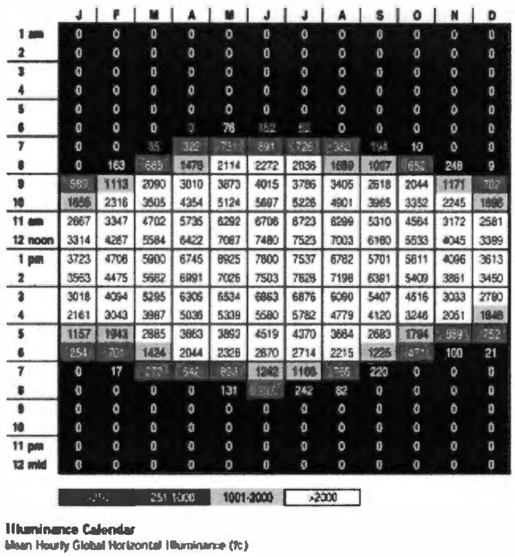
(Fig. 55) - Knoxville wind rose January

building.

Sun Path Diagram (Fig. 52) - This tool can be used to determine the times of the day and year in which the sun will be available on a particular site. Designers can check the solar access of their site at any date and daylight hour. The sun path in the Knoxville area ranges from about 30 degrees in December and about 78 degrees in June.

Solar Radiation (Fig. 53) - This design tool is used to determine the times of the year when solar heating can optimized. Radiation levels in the Knoxville area considered to be moderate to high. Radiation levels are above 200 Btu/h, sq. ft. between the hours of 10am and 3pm during June and July, as well as the hours of 11am to 3pm during the month of May. Radiation effects the times at which shading is recommended and hours at which radiation is between 75 and 200 btu/h, sq. ft.

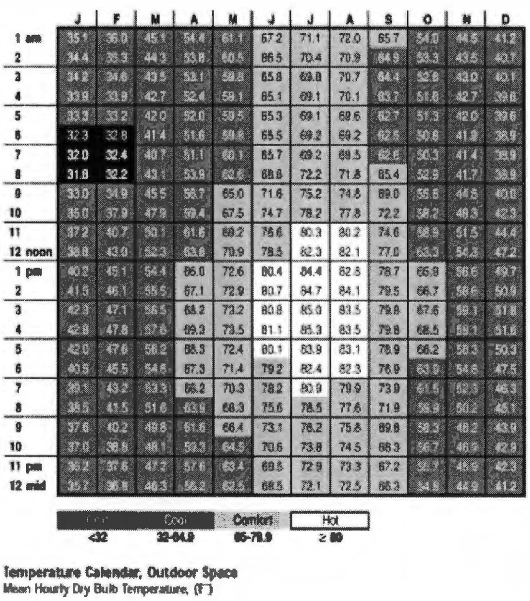
Wind Rose (Fig. 54 & 55) - This chart is used to determine the direction and frequency of wind in the location of a building. In the Knoxville area Summer winds (March to July) blow



(Fig. 56) - Knoxville daylight availability

from predominantly the Southwest and west-southwest nearly one third of the time. Winter winds (August to February) blow from the same direction about a quarter of the time. In this area operable inlets should be placed on the west and southwest of the building and outlets on the northeast, northwest, and southeast, which will utilize the prevailing summer wind. In all seasons in this area there is a strong wind current in the northeast and southwest direction due to the surrounding topography and direction of the valley. For building oriented in a north/south direction outdoor rooms located on the west or south will have access to the prevailing summer breezes and west will be most beneficial for morning shade. For buildings oriented in line with the prevailing wind direction locating an outdoor room on the northwest corner which would catch the summer breeze and be shaded from most of the summer sun.

Daylight Availability (Fig. 56) - The data in this tool is used to determine required daylight factors for design. This chart is based on available exterior illuminance and required interior illuminance (based on use, task, or atmosphere) along with the design daylight factor. Even though the



(Fig. 57) - Knoxville temperature calander

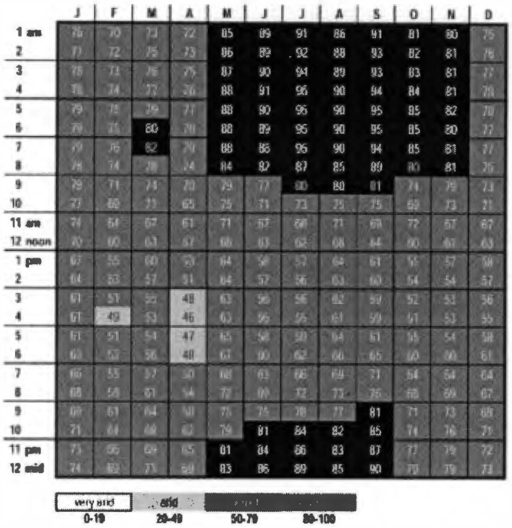
Knoxville area is overcast most of the year besides September and October, the hourly Illuminance Calendar shows a mean global horizontal illuminance over 1000 foot-candles during day light hours.

Comfort: Temperature Calendar (Fig. 57) - This chart will help show the times when cooling or heating is necessary in an Outdoor Space, a Skin-Load-Dominated Building, and an Internal-Load-Dominated Building. When the Temperature Calendar indicates a comfort or hot conditions, then shading should be incorporated into the design and buildings that have thermal mass to store heat for night cooling can remove most shading during the winter months. In the Knoxville area the outside temperature in May is mostly comfortable from about 9am to 9pm and cool from about 10pm to 8am. These are considered to be 'transitional months'.

Outdoor Rooms: Cooling - June to August; Heating - October to April

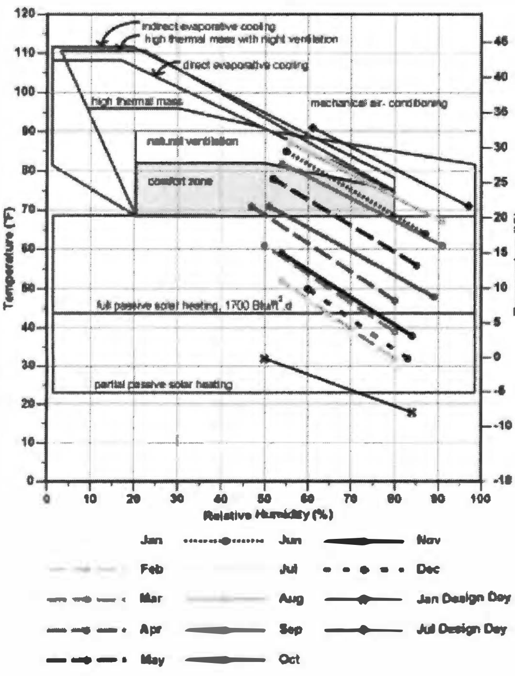
Skin Loaded Dominated: Cooling - May to September; Heating - November to March

Internal Loaded Dominated: Cooling - April to October; Heating - December to February



Relative Humidity Calendar
Mean Hourly Relative Humidity (%)

(Fig. 58) - Knoxville realative humidity



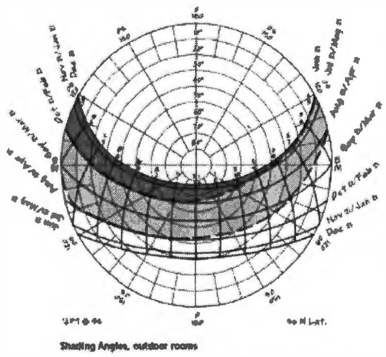
Building Bioclimatic Chart

(Fig. 59) - Building bioclimatic chart

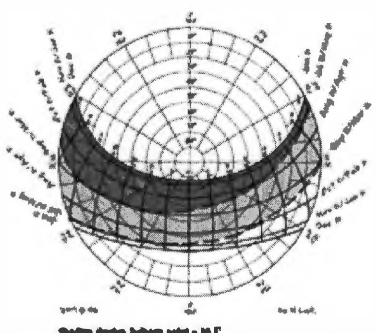
Comfort: Relative Humidity (Fig. 58) - The warm air of the Knoxville area holds more moisture than cold air. The summers in this area can become very humid with the relative humidity ranging from 60% in the afternoons to 95% in the early mornings. Humidities are almost always over 50% all year round and the combination of heat and humidity makes cooling passively becomes very difficult. In the summer months cooling by evaporation as well as cooling by convection and radiation become very difficult. Temperatures above 85F degrees ventilation will not increase comfort and other cooling techniques will have to be implemented. Cooling strategies such as night cooled mass and night cooling the interior core of floor slabs and walls with the assistance of fans. According to the comfort zone people are most comfortable at the relative humidity of the 20% to 80%, therefore it is important to avoid sources of additional humidity such as pools and fountains that are in the direction of the prevailing winds.

Comfort: Building Bioclimatic Chart

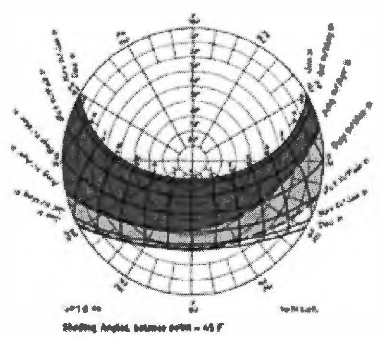
(Fig. 59) - This chart is used to determine architectural responses to achieve thermal comfort in a specific climate zone. This chart is only applicable to buildings and



(Fig. 60) - Knoxville comfort shading angle - outdoor rooms



(Fig. 61) - Knoxville comfort shading angle - balance point 55 degrees

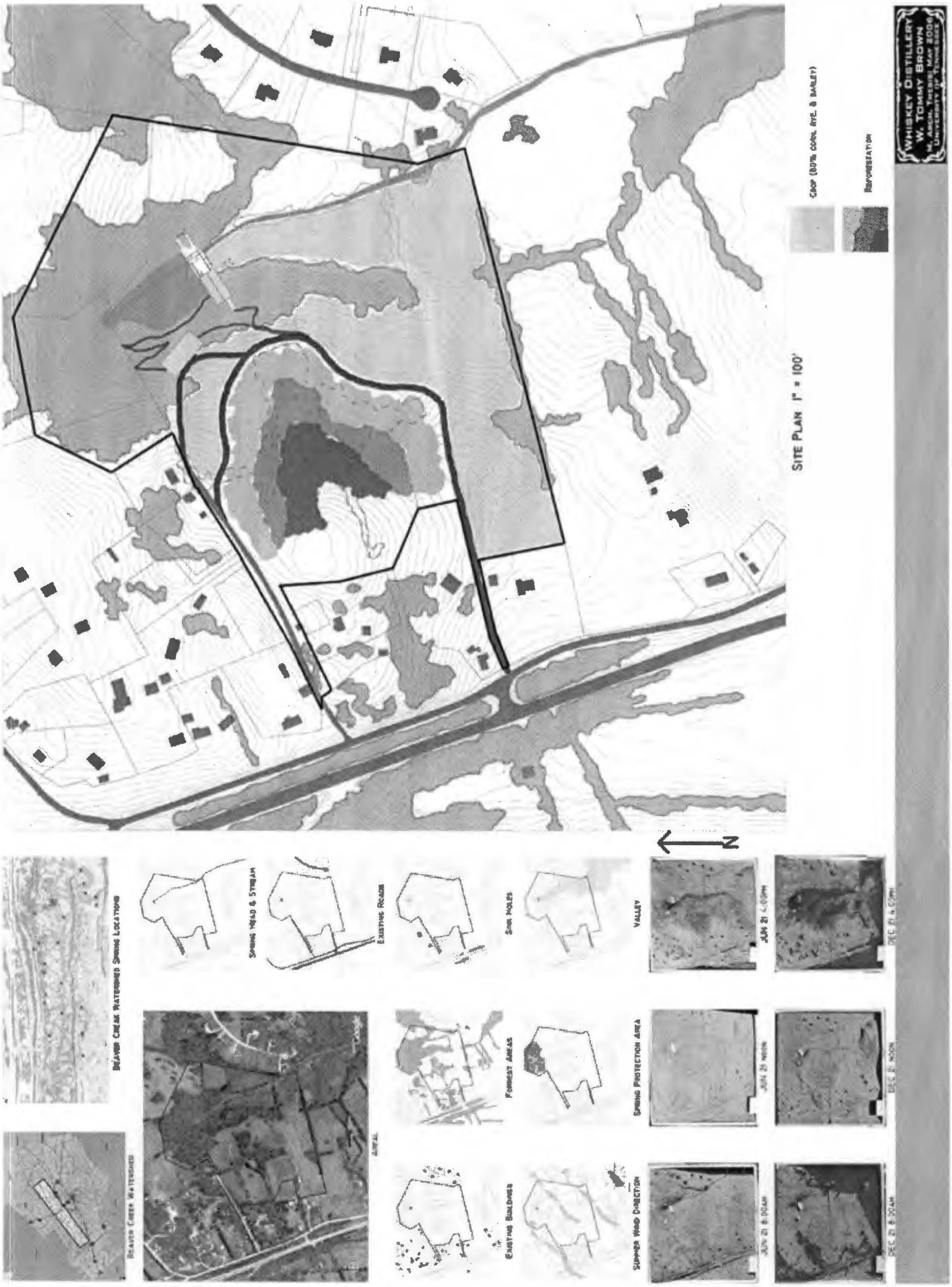


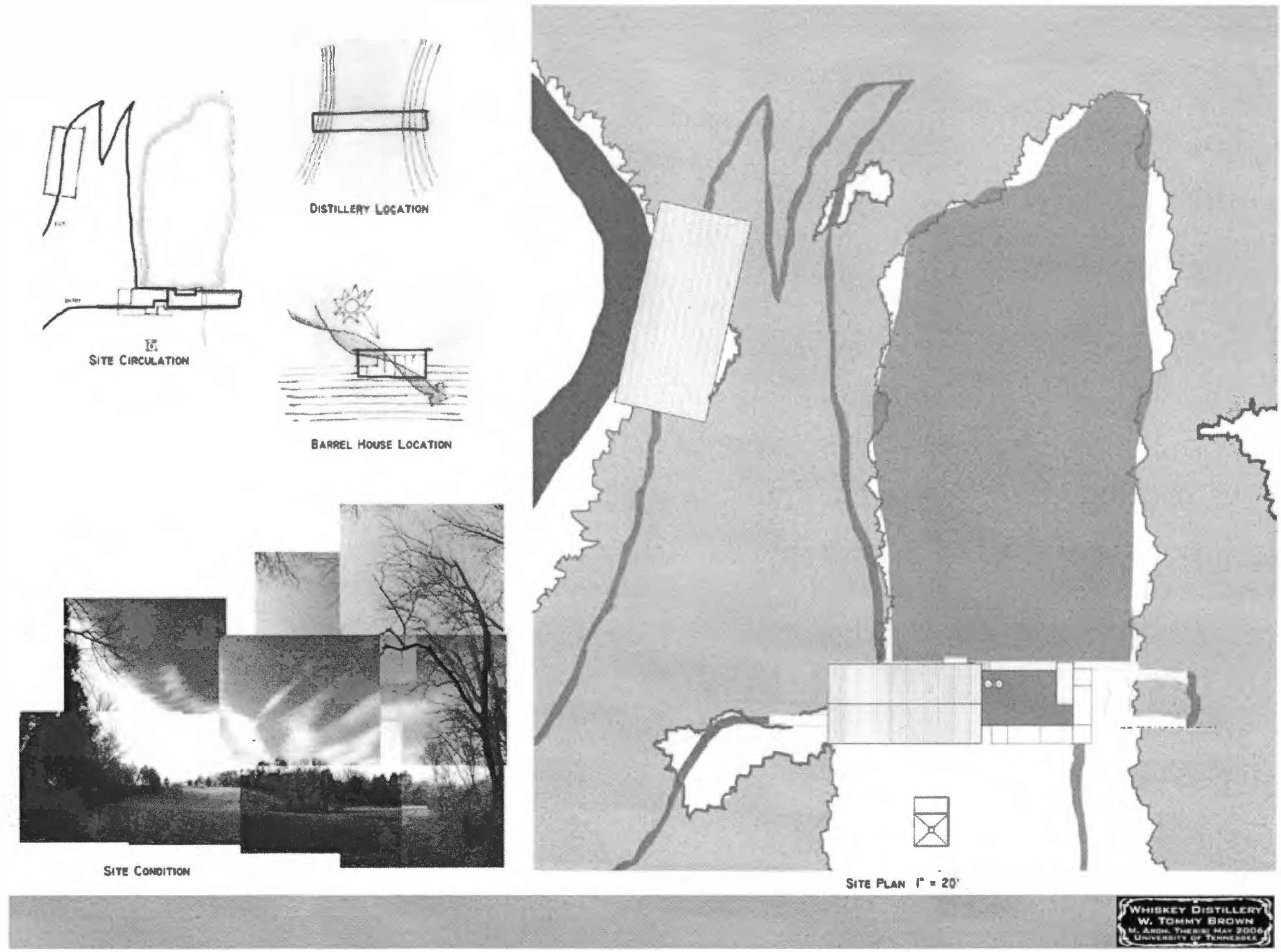
(Fig. 62) - Knoxville comfort shading angle - balance point 45 degrees

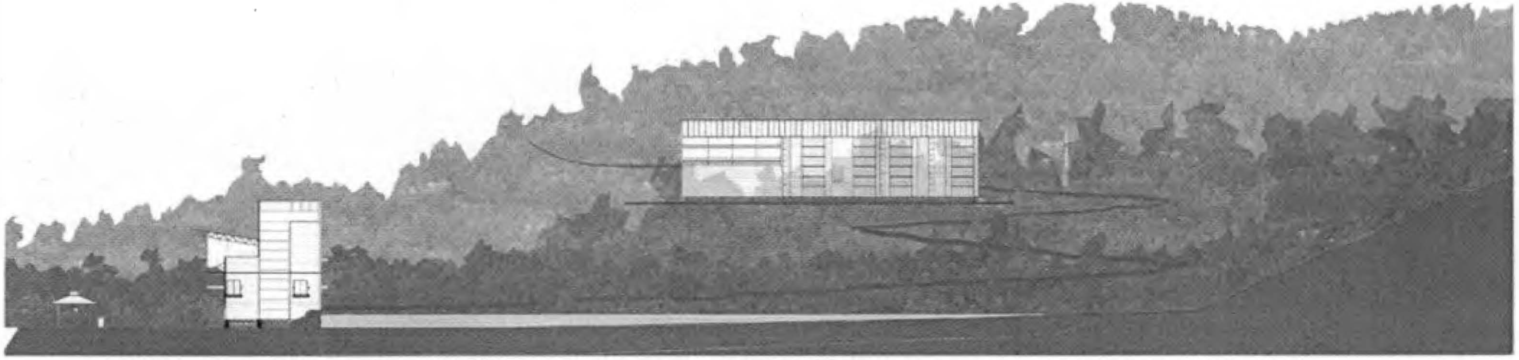
residences with light internal gains from lights, people, and equipment. Each line represents the typical temperature and humidity range for a typical day of that month. In the Knoxville area the plotted lines tend to lean towards the humid side of the chart. In the cold months of December, January and February it is possible to partially heat the building passively. While in the months of March, April, October, and November it is very possible to heat a building entirely by the sun. For the hotter months all the daytime average highs fall within the zone where natural ventilation is will me appropriate to cool a building, but other lines indicate that this passive technique may not be enough to achieve a comfort level.

Comfort: Shading Angles (Fig. 60, 61, & 62) - Through the use of the Sun Path Diagram a designer can determine appropriate shading angles for blocking the sun. From the times and dates on the Temperature Calendars where overheating occurs one can plot the sun path to determine the sun angles that require shade. For an effective design scheme one needs to know when to block the sun light and when to allow for sun light. For outdoor spaces a designer needs to plan for shading during the times when the conditions are within or above the comfort zone listed in the bioclimatic chart. Buildings require shading whenever the outdoor temperature is able the building's balance point temperature. Note that ILD buildings (internal-load-dominated) have a lower balance point (45F degress) than SLD buildings (skin-load-dominated) (55F degrees) and therefore shift to required heating at a lower outdoor temperature and have a longer season for shading.

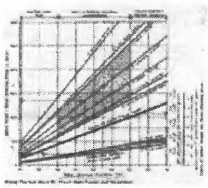
Final Design Project



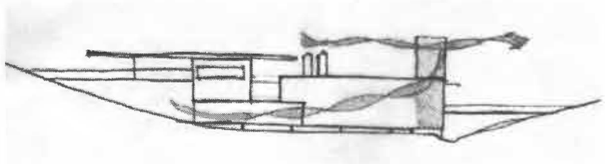

SITE CIRCULATION
DISTILLERY LOCATION
BARREL HOUSE LOCATION
SITE CONDITION
SITE PLAN 1" = 20'
WHISKEY DISTILLERY
W. TOMMY BROWN
M. ARCH. THESIS: MAY 2006
UNIVERSITY OF TENNESSEE



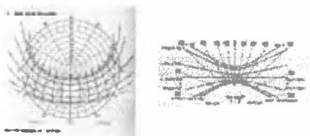
SITE SECTION (EAST ELEVATIONS) 1/16" = 1'



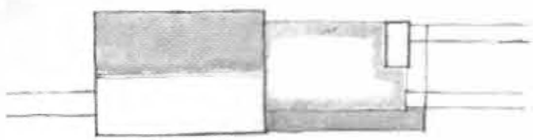
THERMAL MASS SIZING CHART



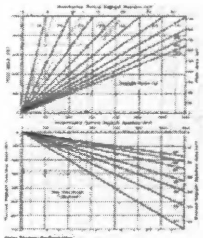
STACKED VENTILATION THROUGH STILL TOWER



SUN PATH CHARTS



PV PANELS (3,520 SF) AND GREEN ROOF



WINDOW SIZING CHARTS

DISTILLERY FOOTPRINT (2,330 SF)

CONCEPTUAL MODEL

WHISKEY DISTILLERY
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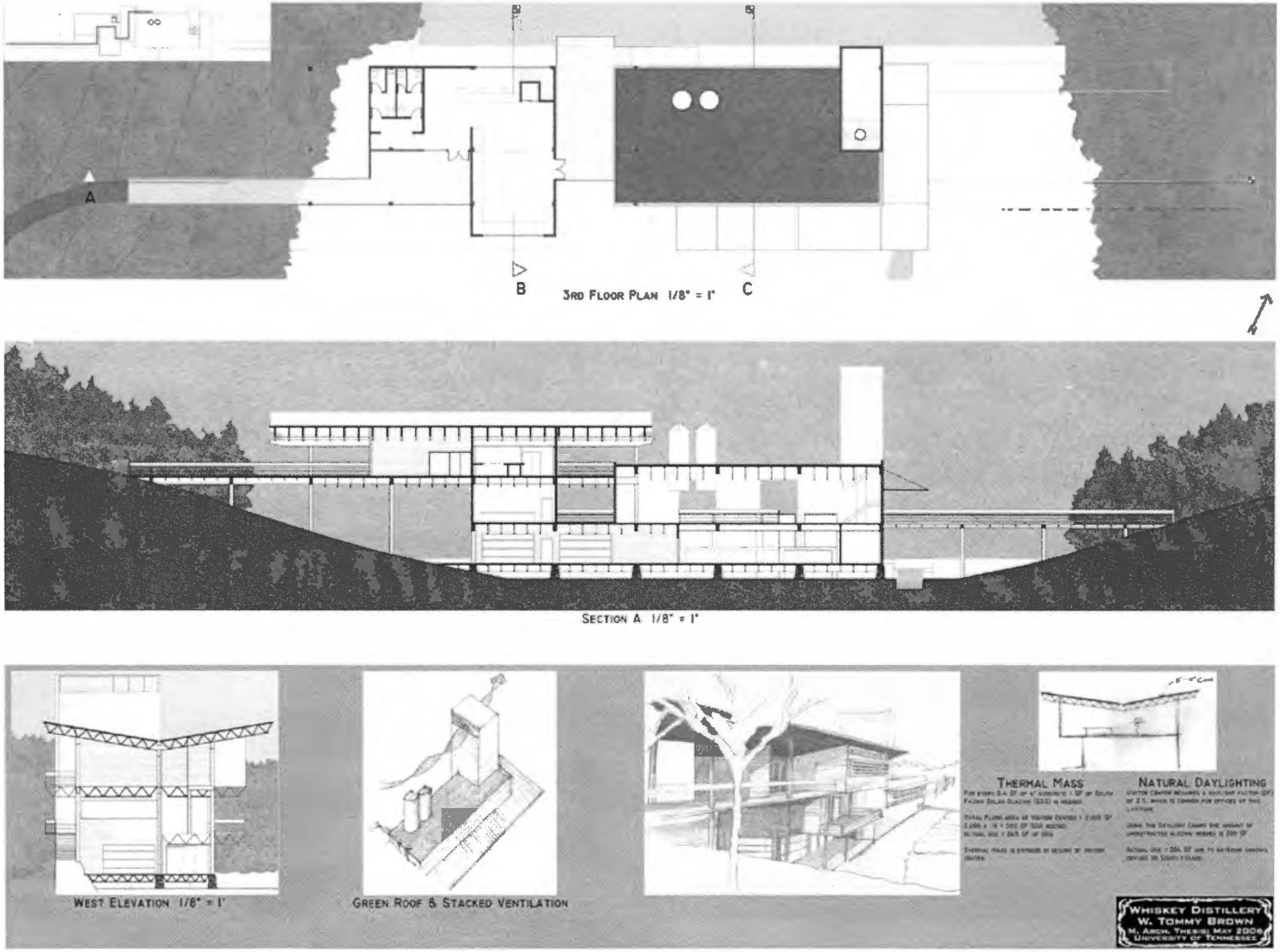
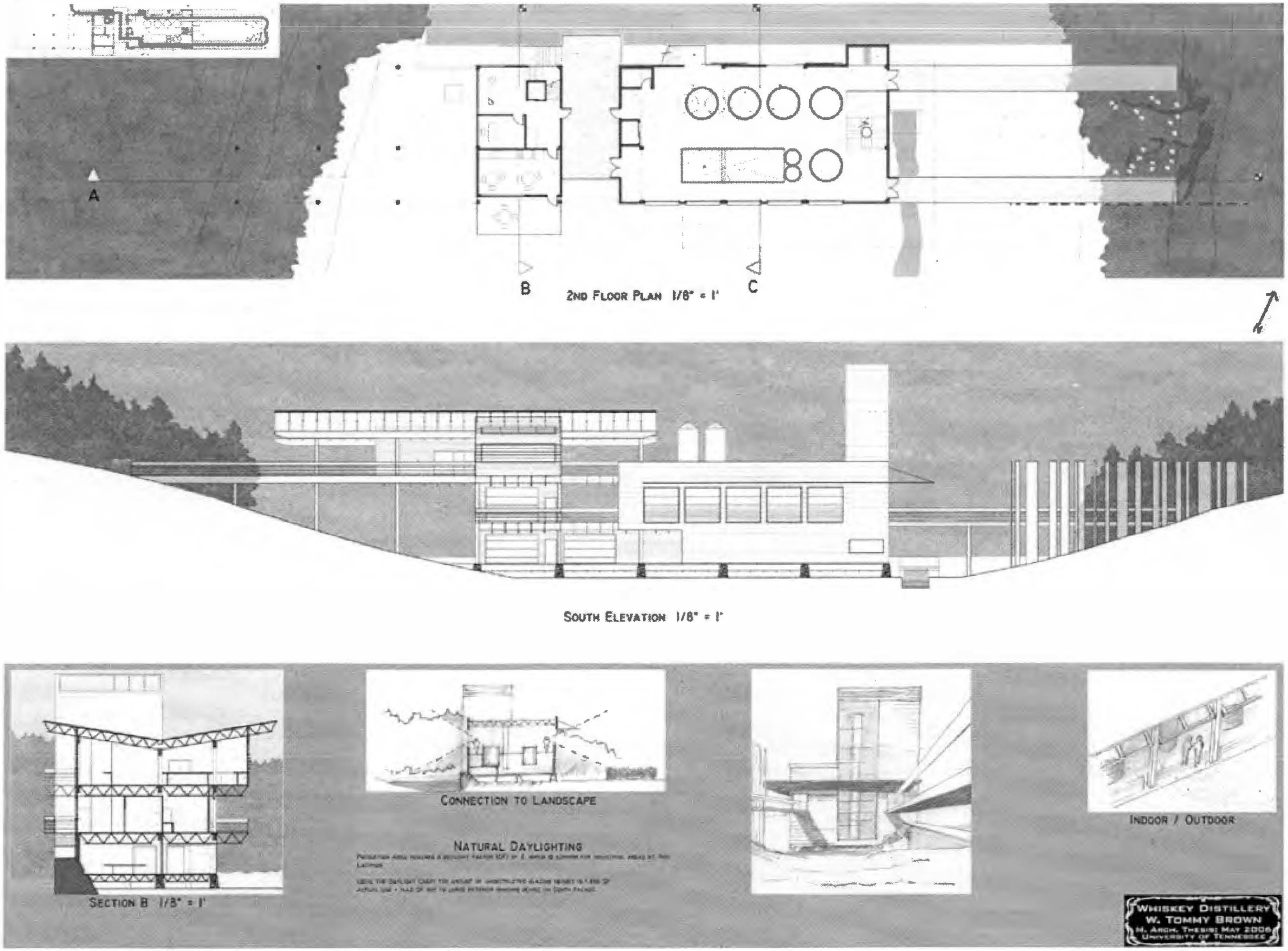
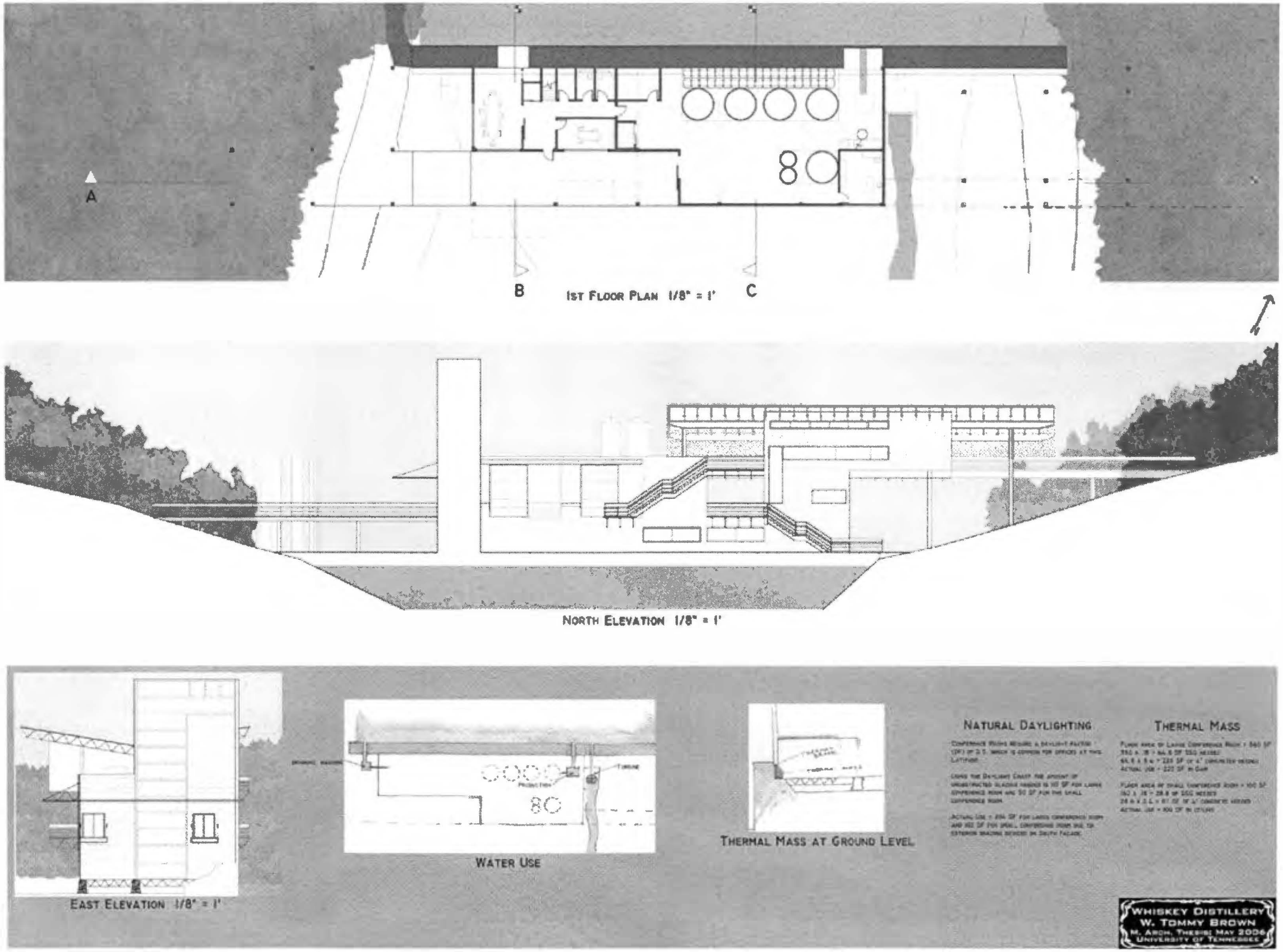
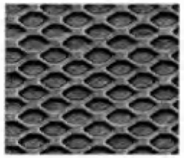
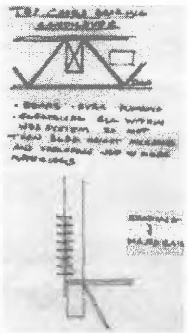
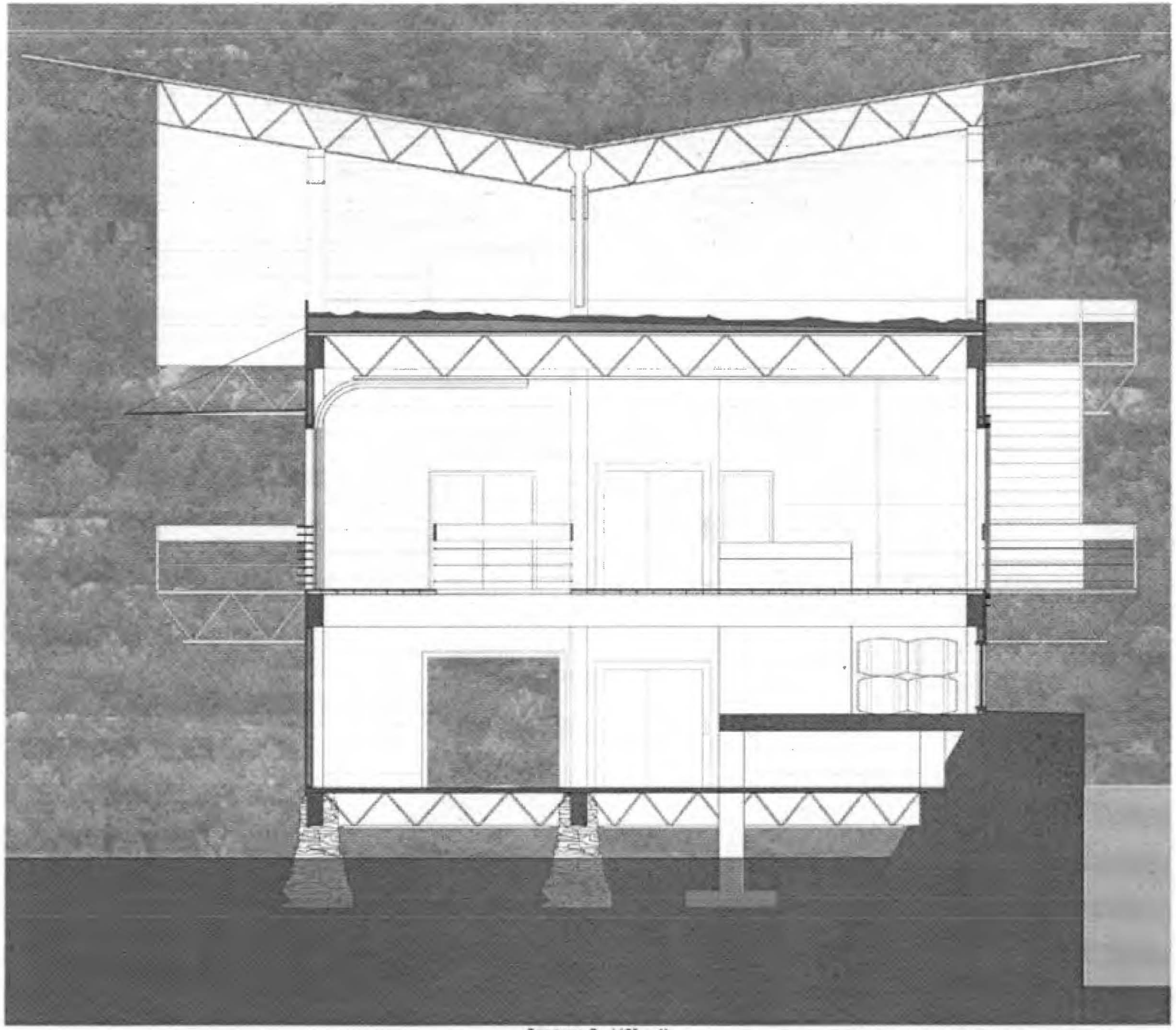

A
B
C
3RD FLOOR PLAN 1/8" = 1'
SECTION A 1/8" = 1'
WEST ELEVATION 1/8" = 1'
GREEN ROOF & STACKED VENTILATION
THERMAL MASS
NATURAL DAYLIGHTING
WHISKEY DISTILLERY
W. TOMMY BROWN
M. ARCH. THESIS: MAY 2006
UNIVERSITY OF TENNESSEE


A
B
C
2ND FLOOR PLAN 1/8" = 1'
SOUTH ELEVATION 1/8" = 1'
SECTION B 1/8" = 1'
CONNECTION TO LANDSCAPE
NATURAL DAYLIGHTING
INDOOR / OUTDOOR
WHISKEY DISTILLERY
W. TOMMY BROWN
M. ARCH. THESIS: MAY 2006
UNIVERSITY OF TENNESSEE


A
B
1st Floor Plan 1/8" = 1'
C
North Elevation 1/8" = 1'
East Elevation 1/8" = 1'
Water Use
Thermal Mass at Ground Level
Natural Daylighting
Thermal Mass
Whiskey Distillery
W. Tommy Brown
M. Arch. Thesis: May 2006
University of Tennessee

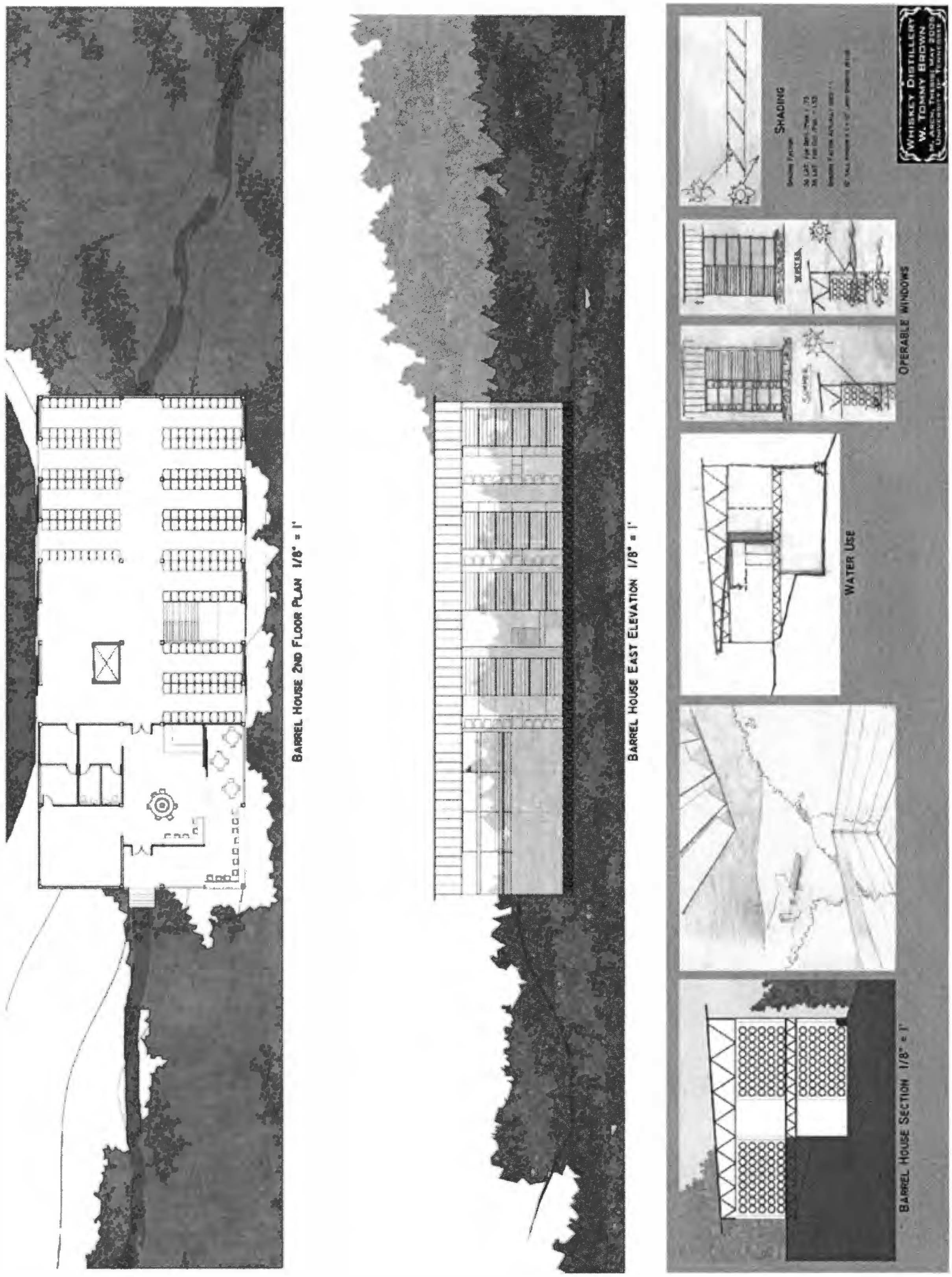






SECTION C 1/2" = 1'

WHISKEY DISTILLERY
W. TOMMY BROWN
M. ARCH. THESIS| MAY 2006
UNIVERSITY OF TENNESSEE



Barrel House 2nd Floor Plan 1/8" = 1'
Barrel House East Elevation 1/8" = 1'
Barrel House Section 1/8" = 1'
Water Use
Operable Windows
Shading
Whiskey Distillery
W. Tommy Brown

VITA

William Thomas Brown, "Tommy", was born and raised in Nashville, Tennessee. After receiving a BA degree from Denison University ('98) where he played NCAA lacrosse, he lived in York, England, London, England, and Chicago, IL. After pursuing unfulfilling careers such as banking and insurance Tommy chose to attend the graduate school of architecture at the University of Tennessee due to his passion to draw. Tommy is a second generation UT architecture graduate and his father has had an extremely successful career in Nashville, TN at his firm of Lawrence P. Brown and Associates. After 3.5 years of pure agony and one asinine public apology to a pathetic professor Tommy has earned his Master of Architecture Degree in August of 2006.